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TWO-SIDED GRINDING APPARATUS

[Ryomen kenma sochi]

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Claims

1. In a two-sided grinding apparatus provided with a carrier in which a through-hole is provided in a thin plate, and with upper and lower platens that holds a plate-like workpiece placed in the through-hole of said carrier and that move relative to said workpiece to grind it, a two-sided grinding apparatus characterized in being provided with a carrier circular motion mechanism that moves the aforementioned carrier in a circular motion, without spinning, within a plane parallel to the plane of said carrier, and that turns the aforementioned workpiece, which is held between the upper and lower platens in the aforementioned through-hole.

2. The two-sided grinding apparatus described in Claim 1 characterized in that the aforementioned carrier circular motion mechanism is provided with:

a carrier holder that holds the aforementioned carrier,

an eccentric arm provided with a holder-side shaft parallel to the axis of the aforementioned upper and lower platens and rotatably attached to the aforementioned carrier holder, and a base-side shaft that is rotatably attached to a base which is parallel to said holder-side shaft and at a prescribed distance, and that moves the carrier holder in a circular motion, without spinning, relative to the base by turning the holder-side shaft centered around the aforementioned base-side shaft,

and a rotary drive apparatus that rotates said eccentric arm centered around the base-side shaft.

3. The two-sided grinding apparatus described in Claim 2 characterized in that a plurality of the aforementioned eccentric arms is provided, and the aforementioned base-side shafts are connected by a synchronizing means, such as a timing chain, so that said plurality of eccentric arms move circularly in synchronization.

Detailed explanation of the invention

[0001]

Technical field of the invention

The present invention relates to a two-sided grinding apparatus. As a two-sided grinding apparatus, planet gear mechanisms in which a gear corresponding to the planet gear carrying the processed material (referred to as "workpiece" hereafter) is caused to spin, as well as revolve, while upper and lower platens that have grinding surfaces placed above and below the carrier also hold the workpiece from above and below and that move relative to the workpiece to grind it, by an outside gear (hereafter referred to as "external gear") and an inside gear (hereafter referred to as "internal gear") being rotated at different angular speeds. Such two-sided grinding apparatuses are used as lapping apparatuses (lapping machines), or polishing apparatuses, and because two sides can be ground simultaneously with high precision, and because processing time is short, they are suited to grinding of thin articles, such as silicon wafers, which are the base material for semiconductor chips.

[0002]

Prior art

The constitution of a polishing apparatus using a conventional planet gear mechanism will be explained based on Figure 3. 112 is an upper platen, 114 is a lower platen, and abrasive cloth is attached to their surfaces to form the grinding surfaces. 116 is an external gear, and 118 is an internal gear. 120 is a carrier, and a workpiece 121 is held in a through-hole provided through carrier 120, and rotates gripped between external gear 116 and internal gear 118. Upper platen 112 is linked to an upper platen lathe dog 112a, and a gear 112c is provided at the end of shaft 112b suspended from upper platen lathe dog 112a. Gear 112c meshes with an idle gear 112d, and idle gear 112d meshes with a gear 112e. Gear 112e is

provided coaxially with a spindle 126 to rotate integrally with spindle 126. Lower platen 114 is linked to a gear 114b furnished coaxially with spindle 126 through a gear 114a provided coaxially with lower platen 114. External gear 116 is linked to a transmission gear 116b provided coaxially with spindle 126 through a gear 116a provided coaxially with external gear 116. Internal gear 118 is linked to a transmission gear 118b provided coaxially with spindle 126 through a gear 118a provided coaxially with internal gear 118. In short, the polishing apparatus drives external gear 116, internal gear 118, and upper and lower platens 112 and 114 with one drive apparatus, which is termed a four-way drive system. Note that spindle 126 is connected to a variable speed reducer 132, variable speed reducer 132 is connected with a motor 134 through a belt 136, and the speed of rotation of spindle 126 is controlled.

[0003]

With a polishing apparatus using such a planet gear mechanism, for example, when the rotation ratio of gear 116 and transmission gear 116b, and the rotation ratio of gear 118a and transmission gear 118 are set so that the angular speed of internal gear 118 is greater than the angular speed of external gear 116, gear 120 meshed between external gear 116 and internal gear 118 revolves in the same direction as the direction of rotation of internal gear 118 (assume it to be "counterclockwise" for example), and spins clockwise. Lower platen 114 also rotates counterclockwise in the same way, but upper platen 112 rotates clockwise since idle gear 112d is interposed. Note that the direction of rotation, the rotation speed, etc., of gear 120 can be changed by setting the angular speeds of external gear 116 and internal gear 118. A liquid abrasive containing a slurry or the like is supplied to the ground surfaces on the front and back of workpiece 121, and grinding of workpiece 121 by the action of the liquid abrasive is suitably performed. With such a polishing apparatus, because carrier 120 can be moved in a complex manner, uneven grinding is prevented, and workpiece 121 (a silicon wafer, for example) can be ground. Therefore, the flatness of

the workpiece can be improved. Grinding efficiency can also be improved, since both sides of workpiece 121 can be ground simultaneously.

[0004]

Problems to be solved by the invention

However, with a two-sided grinding apparatus that uses a conventional planet gear mechanism, because of the structure in which carrier 120 moves between external gear 116 and internal gear 118, it is difficult to accommodate a larger workpiece 121, such as the most recent silicon wafers. That is, the problem is that it is impossible to make the diameter of carrier 120 larger than the radius of the platens, and the platen grinding surfaces cannot be used efficiently. Also, two-sided polishing apparatuses that use a conventional planet gear mechanism have a complicated gear mechanism, it is difficult to make them larger, and there are problems with the materials, processing and installation space for manufacturing larger apparatuses, so there are problems of enormous cost from various aspects.

[0005]

Thus, the objective of the present invention is to provide a two-sided polishing apparatus that prevents uneven wafer grinding and that can improve wafer flatness, as well as efficiently utilizing the platen grinding surfaces by satisfactorily accommodating larger workpieces, that does not require a complicated constitution, and that can reduce manufacturing cost.

[0006]

Means to solve the problems

To accomplish the aforementioned objective, the present invention has the following constitution. In short, with a two-sided grinding apparatus provided with a carrier in which a through-hole is formed in a thin plate, and with upper and lower platens that hold a plate-like workpiece placed in the through-hole in said carrier from above and below and that move relative to said workpiece to grind it, the present invention is provided with a carrier circular motion mechanism that moves the aforementioned carrier in a circular motion, without spinning, in the plane parallel to the plane of said carrier, and turns the aforementioned workpiece held between the upper and lower platens in the aforementioned through-hole.

[0007]

The aforementioned carrier circular motion apparatus [sic; mechanism] is provided with a carrier holder that holds the aforementioned carrier; an eccentric arm provided with a holder-side shaft parallel to the axis of the aforementioned upper and lower platens and rotatably attached to the aforementioned carrier holder, and a base-side shaft that is rotatably attached to a base which is parallel to said holder-side shaft and at a prescribed distance, and that moves the carrier holder in a circular motion without spinning relative to the base by turning the holder-side shaft centered around the aforementioned base-side shaft; and a rotary drive apparatus that rotates said eccentric arm centered around the base-side shaft. Thus while having a simple configuration, the carrier held in the carrier holder can satisfactorily be moved circularly without spinning.

[0008]

By also providing a plurality of the aforementioned eccentric arms, and linking the aforementioned base-side shafts to each other with a synchronizing means, such as a timing chain, so that said plurality of eccentric arms move circularly in synchronization, the carrier can be moved satisfactorily and reliably.

[0009]

Embodiment of the invention

A preferred application example of the present invention will be explained in detail below based on the attached figures. Figure 1 is an oblique assembly diagram schematically showing an application example of a two-sided grinding machine pertaining to the present invention, and Figure 2 is a side cross section showing the relative positions of the components when the application example in Figure 1 operates. This application example is a two-sided grinding apparatus to grind silicon wafers 10, which are the plate-like workpieces, and is provided with a carrier 12 in which through-holes 12a are provided in a thin plate, and with upper and lower platens 14 and 16 that hold wafers 10 placed in the through-holes in carrier 12 from above and below and that move relative to wafers 10 to grind them. Abrasive cloth 14a and 16a, are attached to the surfaces of upper and lower platens 14 and 16, respectively, and grinding faces are formed by abrasive cloth 14a and 16a. Wafers 10 are held loosely in circular through-holes 12a, which have a circular shape, and are sized to be able to spin freely in through-holes 12a.

[0010]

20 is a carrier circular motion mechanism, and carrier circular motion mechanism 20, which moves carrier 12 in a circular motion without spinning in a plane parallel to the plane of carrier 12, and that turns wafers 10 held between upper platen 14 and lower platen 16 in through-holes 12a, has the following

constitution. 22 is a carrier holder, which is formed in a ring shape and has a ring body 22a and a holding ring 22b. The outside edge of circular carrier 12 is gripped by ring body 22a and holding ring 22b, and carrier 12 is held in ring holder 22.

[0011]

24 is an eccentric arm, and is provided with a holder-side shaft 24a which is rotatably attached to carrier holder 22 parallel to axis L of upper and lower platens 14 and 16, and a base-side shaft 24b that is rotatably attached to a base 30, which is parallel to carrier holder-side shaft 24a and at a prescribed distance (refer to Figure 2). That is, it is formed to provide the same mechanisms as the crank arm of a crank mechanism. An eccentric arm 24, in this embodiment, is placed at four locations between base 30 and carrier holder 22, and by holding carrier holder 22 as well as turning holder-side shaft 24a around base-side shaft 24b, carrier holder 22 is moved circularly without spinning relative to base 30. Holder-side shafts 24a are inserted and attached to be able to rotate in bearings 22c provided projecting on the outer circumferential surface of carrier holder 22. With this, carrier 12 turns (circular motion without spinning) with eccentricity M from axis L of upper and lower platens 14 and 16. The radius of the circular motion is the same as the distance between holder-side shaft 24a and base-side shaft 24b (distance of eccentricity M), and all points on carrier 12 move, tracing the same small circular path.

[0012]

28 is a timing chain and is hooked around sprockets 25 (four in this embodiment) which are affixed coaxially with the base-side shaft 24b of each eccentric arm 24. Timing chain 28 and the four sprockets 25 constitute a synchronizing means that link and synchronize the four base-side shafts 24b with each other so that the four eccentric arms 24 move circularly in synchronization. This synchronizing means is a

simple constitution, and can move carrier 12 satisfactorily and reliably. Grinding precision can be improved and wafer flatness can be improved by this. Note that the synchronizing means is not limited to this application example, and of course a timing chain, or gears or the like could also be used. 32 is a motor (a gear motor, for example), and 34 is an output gear affixed to the output shaft. Output gear 34 meshes with gear 26 affixed coaxially to base-side shaft 24b of eccentric arm 24. A rotary drive apparatus that rotates eccentric arm 24 around base-side shaft 24b is constituted with this.

[0013]

Note that multiple motors (electric motors, for example) placed corresponding to each eccentric arm 24 can also be used for the rotary drive apparatus. With electric motors, multiple eccentric arms 24 can be synchronously moved and carrier 12 can be moved smoothly by synchronizing electrically. Also, in this application example, a case in which four eccentric arms 24 are provided is explained, but the present invention is not limited to this, and carrier holder 22 can be satisfactorily supported with a minimum of three eccentric arms 24. In addition, if carrier holder 2 can be moved integrally with a moving body, and XY table, with which two-dimensional motion can be achieved with synthesis of linear movement on two perpendicular axes, carrier holder 22 can be moved circularly, without spinning, driven with one eccentric arm 24. That is, the aforementioned moving body moves without spinning by being guided by guides that extend to the two perpendicular axes of the XY table, and the motion of the moving body can be satisfactorily used for motion (circular motion without spinning) by carrier holder 22. Also, by using (controlling) an XY table drive mechanism, for example, a drive mechanism comprising servo motors and timing chains or ball screws, etc., placed on both the X axis and the Y axis, without using eccentric arms 24, carrier holder 22 can be moved (circular motion without spinning) integrally with the aforementioned moving body. In this case, two motors will be used, and various two-dimensional motions

in addition to circular motion without spinning can be obtained by controlling the motors, and this motion can be used to grind wafers 10.

[0014]

36 is a lower platen rotating motor, and is a power apparatus that rotates lower platen 16. For example, a gear motor can be used as in this application example, and the output shaft thereof could be directly connected to the rotary shaft of lower platen 16. 38 is a power means for upper platen rotation, and rotates upper platen 14. If lower platen rotary drive motor 36 and power means 38 for upper platen rotation are of the type in which the direction of rotation and rotation speed can be freely changed, various grinding specifications can be accommodated flexibly. Also with this two-sided grinding apparatus, wafer 10 placed in through-hole 12a of carrier 12 is sandwiched by upper platen 14 and lower platen 16 as shown in Figure 2, and the wafer is ground. In this instance, the force with which wafer 10 is gripped is primarily produced by a pressing means (not shown) provided on the side with upper platen 14. For example, upper platen 14 could be pressed against wafer 10 with an air bag system that uses air pressure. The applied pressure can be adjusted satisfactorily and easily by controlling the air pressure. Note that on the side with upper platen 14, in addition to a pressure means, an elevating apparatus 40 that raises or lowers upper platen 14 is provided and operates when wafers 10 are supplied or discharged.

[0015]

Next, the method of use of the present invention will be explained. First, a case in which the upper platen 14 and lower platen 16 are rotated in the opposite directions such the absolute values of their rotation speeds are the same, without moving carrier 12, will be explained. In short, as shown in Figure 1, upper platen 14 is rotated clockwise and lower platen 16 is rotated counterclockwise, for example. In this

case, abrasive forces will act in exactly the opposite directions, so the forces of motion thereof are mutually canceled, and theoretically both sides of wafer 10 are ground while it is stationary. However, in this case, the peripheral speeds of upper platen 14 and lower platen 16 become greater toward their outer peripheries. Therefore, grinding is accelerated in portions of wafer 10 farther from portions corresponding to axis L of upper and lower platens 14 and 16, and wafer 10 will not be ground uniformly.

[0016]

Next, grinding action produced by carrier 12 being moved circularly without spinning with a movement mechanism comprising the constitution described above will be explained. When only circular motion without spinning by carrier 12 is considered, without considering the rotation of upper and lower platens 14 and 16, with the circular motion without spinning, exactly same motion occurs at all points on the member (carrier 12) that moves. This is a type of oscillating motion, in the sense that all points have the same motion, and the track of the oscillation motion may be considered to be a circle. Therefore, if wafer 10 is turned via carrier 12, which moves circularly without spinning, both sides of wafer 10 will be ground uniformly, speaking only of the action produced by that motion.

[0017]

Then when rotation motion by upper platen 14 and lower platen 16, and circular motion without spinning by carrier 12 function simultaneously, because wafer 10 is held rotatably in through-hole 12a, particularly when a difference in the absolute values of the rotation speed of upper platen 14 and lower platen 16 is provided (when the rotation speed of one platen is faster relative to the other platen), wafer 10 turns in the direction of rotation of the platen with the faster rotation speed. That is, wafer 10 will spin in a prescribed direction. By wafer 10 spinning in this way, while the peripheral speeds of upper platen 14 and

lower platen 16 become greater toward their outer peripheries, the effect thereof can be eliminated, and wafer 10 can be ground uniformly. Note that to uniformly grind both sides of wafer 10, upper platen 14 and lower platen 16 could be controlled so that the rotation speed of one is alternately faster.

[0018]

Next, another method of use of the present invention will be explained. With the application example above, a case in which multiple through-holes 12a are provided and multiple workpieces (wafers 10) are ground simultaneously was explained, but the present invention is not limited to this. For example, only one through-hole 12a in which a large workpiece is held can be provided on carrier 12, and can be used as a grinding apparatus to grind both sides of the large workpiece. Note that examples of large workpieces include workpieces such as rectangular glass plates used for liquid crystals, or wafers (round) processed in sheets. In this case, the large workpiece is placed over roughly the entire surface from the center of carrier 12 to near its peripheral edge. In this case, [the workpiece] is ground primarily using the circular motion without spinning produced by carrier 12, and if the rotation speeds of upper platen 14 and lower platen 16 are slow enough that no uneven grinding occurs, the entire surface of the workpiece can be ground uniformly and satisfactorily. That is, while the grinding action by upper platen 14 and lower platen 16 becomes larger at the outer periphery where peripheral speed is farther [sic], if their rotation speed is very slow compared to the circular motion without spinning by carrier 12, it is possible for them to minimally participate directly in the grinding action. Then the rotating of upper platen 14 and lower platen 16 can satisfactorily participate indirectly to make the grinding action better, such as always changing the platen surface touching the workpiece and supplying liquid abrasive evenly to the entire workpiece surface.

[0019]

The application example above was explained for a polishing apparatus, but the present invention can also, of course, be applied satisfactorily to a lapping apparatus. The present invention was explained above citing various preferred application examples, but the present invention is not limited to the application examples, and many modifications can, of course, be implemented within a range that does not deviate from the spirit of the present invention.

[0020]

Effects of the invention

With this invented two-sided grinding apparatus, a carrier is moved circularly without spinning in a plane parallel to the plane of the carrier by a carrier circular motion mechanism, and a workpiece held between upper and lower platens in a through-hole in the carrier is turned. The same motion is provided on all portions of the carrier by the circular motion without spinning, so that the wafer can be ground uniformly, and at the same time, the entire surface of the carrier and the upper and lower platen grinding surfaces can be utilized efficiently. For this reason, uneven grinding of the wafer is prevented and wafer flatness can be improved, while there is also the effect that larger workpieces can be satisfactorily accommodated and the platen grinding surfaces can be utilized efficiently. Also, the constitution is not complicated, and can satisfactorily accommodate large sizes, compared to two-sided grinding apparatuses that use conventional planet gear mechanisms, and there is the noticeable effect that manufacturing cost can be reduced.

Brief description of the figures

Figure 1 is an oblique assembly diagram of an application example of a two-sided grinding apparatus pertaining to the present invention.

Figure 2 is a side cross section of the application example in Figure 1.

Figure 3 is a side cross section illustrating the prior art.

Explanation of symbols

10	Wafer
12	Carrier
12a	Through-hole
14	Upper platen
16	Lower platen
20	Carrier circular motion mechanism
22	Carrier holder
24	Eccentric arm
24a	Holder-side shaft
24b	Base-side shaft
28	Timing chain
30	Base

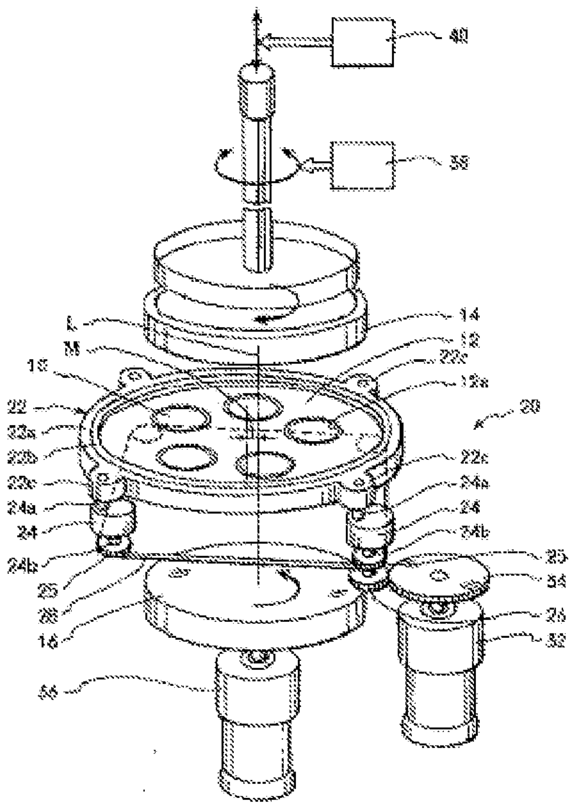


Figure 1

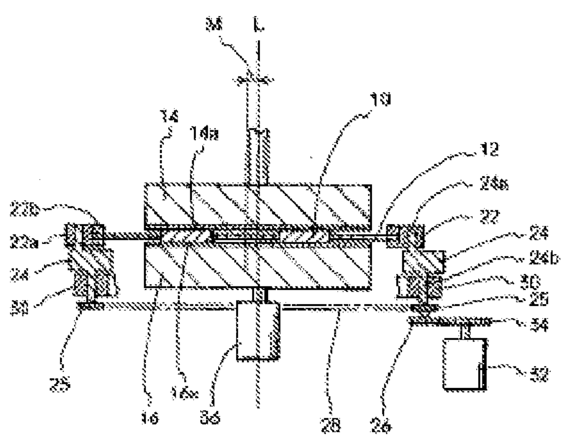
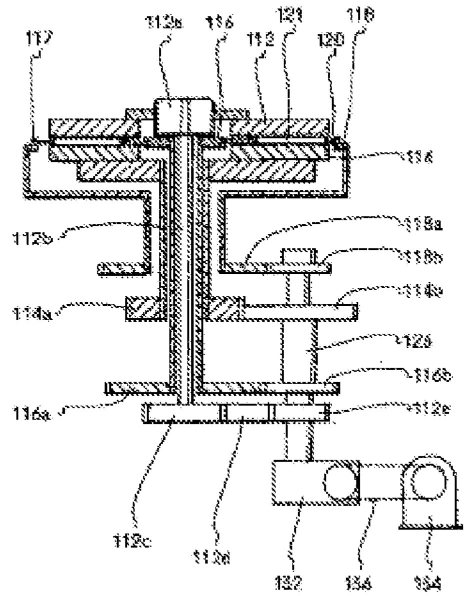


Figure 2



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112b
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118b
114a
114b
129
116b
116a
112e
112c
112d
132
134
154

Figure 3